Gamma-ray Large Area Space Telescope (GLAST)
GLAST Front End Processor (GFEP) Functional and Performance Specification

February, 2004

DRAFT

Revision A

Abstract

The GLAST Front End Processor (GFEP) will provide a Consultative Committee for Space Data Systems (CCSDS) real-time return link data processing capability for data delivered through the Space Network via the Ku-band in support the GLAST program. This Functional and Performance Specification document is written in accordance with GLAST Project direction.

This F&PS specifies the real-time high-rate data processing requirements to be met by the GFEP, which are in accordance with the GLAST Ground System Requirements Document (GSRD). The GLAST Project has reviewed these requirements and has concurred with them.

Keywords:

CCSDS
Gamma-ray Large Area Space Telescope (GLAST)
GLAST Front End Processor (GFEP)
Tracking and Data Relay Satellite System (TDRSS)
Ku-band Return Link

TABLE OF CONTENTS

List of Figures

Section 1 — Introduction

1.1 Background

The GLAST Front End Processor (GFEP) provides support to the National Aeronautics and Space Administration (NASA) GLAST program. GFEP provides ground services for data distribution and storage for high rate return link data conforming to the Consultative Committee for Space Data Systems (CCSDS) Recommendations for Space/Ground Data Communications. The GFEP provides the capability to use TCP/IP communications protocols for the transfer of real-time data between GSFC-based GLAST Mission Operation Center (MOC) and the WSC-based remote ground terminals.

The GFEP components are physically located at the White Sands Complex (WSC: White Sands Ground Terminal [WSGT] and Second TDRSS Ground Terminal [STGT]). They are remotely controllable from the GLAST Mission Operations Center (MOC) located at the Goddard Space Flight Center (GSFC) in Greenbelt, Maryland.

1.2 Specification Derivation

The functional and performance specifications as contained in this document were derived from the GLAST Mission Systems Specification, the GLAST Spacecraft Performance Specification, the GLAST Ground System Requirements Document, and existing NASA and GSFC standards.

1.3 Document Organization

Section 2 of this document contains reference and applicable documentation. It includes those documents used to derive requirements directly (e.g., the GSRD), documents that contain implied requirements [e.g., existing NASA Interface Control Documents (ICDs)], and standards applicable to GFEP. These latter are industry, military, or international standards, in addition to NASA standards.

Section 3 presents a high-level view of GFEP services and introduces the system-level architecture. GFEP requirements are contained in Section 4. Acronyms are found in Appendix A.

Section 2 — Related Documents

The following documents, of the exact date of issue indicated, are part of this specification to the extent cited herein. If there are conflicts between the listed documents and this specification, this specification shall be considered superseding. In the event of conflict between listed applicable documents, the order of precedence shall be as follows:

a. The requirements of the NASA documents shall take precedence over the requirements of other documents.

b. The requirements of other Government documents shall take precedence over contractor documents and industry standards.

Unless otherwise indicated, the whole document shall apply.

2.1 Applicable Documents

NPD 8010.2C, NASA Policy Directive, Use of the Metric System of Measurement in NASA Programs, July 2000

NPD 2810.1, NASA Policy Directive, Security of Information Technology, October 1998

NPD 2820.1, NASA Policy Directive, NASA Software Policies, May 1998

Recommendation ITU-R SA.1157: Protection Criteria for Deep-Space Research (1995)

DAS to DAS Customers ICD (453-ICD-DAS/Customer)

ICD Between the NCC Data System and MOCs (451-ICD-NCCDS/MOC

2.2 Reference Documents

The following documents are for reference only.

1. 433-OPS-0001, GLAST Operations Concept Document

2. 433-SRD-0001, GLAST Science Requirements Document

3. 433-SPEC-0001, GLAST Project Mission System Specification

4. 433-MAR-0004, GLAST Ground Data System Mission Assurance Requirements

5. CCSDS 101.0-B-5: "Recommendation for Space Data Systems Standards. Telemetry Channel Coding," Blue Book, Issue 5, June 2001

6. CCSDS 102.0-B-5: "Recommendation for Space Data Systems Standards Packet Telemetry," Blue Book, Issue 5, November 2000

7. CCSDS 103.0-B-2: "Recommendation for Space Data Systems Standards Packet Telemetry Service Specification," Blue Book, Issue 2, June 2001

8. CCDS 701.0-B-3: "Recommendation for Space Data Systems Standards Advanced Orbiting Systems, Networks and Data Links: Architectural Specification," Blue Book, Issue 3, June 2001

9. Large Area Telescope-GLAST Burst Monitor Burst Telecommand & Alert Telemetry Interface Control Document, 433, ICD-0001

10. GLAST 1553 Bus Protocol Document, 1196 EI-S46310-000

11. GLAST Science Instrument- Spacecraft Interface Requirements Document - LAT IRD, 433-IRD-0001

12. Large Area Telescope (LAT) to Spacecraft Interface Control Document - 1196 EI-Y46311-000A

13. GLAST Science Instrument- Spacecraft Interface Requirements Document - GBM IRD, 433-MAR-0003

14. GLAST Burst Monitor (GBM) to Spacecraft (SC) Interface Control Document,1196-EI-Y46312-000A

15. ANSI/HFS 100-1988, American National Standard for Human Factors Engineering of Visual Display Terminal Workstations, February 4, 1988.

16. Electrical Characteristics of Balanced Voltage Digital Interface Circuits, Electronic Industries Association (EIA) 422-A, December 1978

17. General-Purpose 37-Position and 9-Position Interface for Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange, EIA 449, November 1977

18. Internet Protocol (IP): DARPA Internet Program Protocol Specification, Request for Comment (RFC) 791, September 1981

19. The Point-to-Point Protocol (PPP), RFC 1661, July 1995

20. An Ethernet Address Resolution Protocol or Converting Network Protocol Addresses to 48-bit Ethernet Addresses for Transmission on Ethernet Hardware, RFC 826, November 1982

21. Internet Control Message Protocol, RFC 792, September 1981

22. Routing Information Protocol (RIP), RFC 1058

23. Open Shortest Path First (OSPF), RFC 1247

24. Internet Group Multicast Protocol (IGMP), RFC 1112

25. On the Assignment of Subnet Numbers, RFC 1219

26. Simple Network Management Protocol (SNMP), RFC 1157

27. Address Resolution Protocol (ARP), RFC 826

28. A Reverse Address Resolution Protocol (RARP), RFC 903

29. Internet Protocol on Ethernet Networks, RFC 894

30. IP Mobility Support, RFC 2002

31. Structure of Management Information, RFC 1155

32. Management Information Base - II, RFC 1213

33. Transmission Control Protocol, RFC 793

34. File Transfer Protocol, RFC 959

35. ISO 8802-2, Logical Link Control (LLC)

36. ISO 8802-3, Carrier-Sense Multiple-Access with Collision Detection (CSMA/CD) Media Access Control (MAC) - Ethernet version 2

37. Institute of Electrical and Electronic Engineers (IEEE) 802.3 10Base-T (twisted pair)

38. IEEE 10Base-5 (thick ethernet), 10Base-T (thin ethernet), 100Base-T (fast ethernet), 10Base-F (ethernet over fiber)

39. 301.0-B-2, Recommendation for Space Data System Standards. Time Code, Blue Book, Issue-2, April 1990.

Section 3 — Functional Overview

This section provides an overview of the GFEP services and operations. For a detailed description of GLAST data rates and operations concepts see the GLAST GSRD.

3.1 GFEP Functions

The GFEP provides communications processing and data handling capabilities in support of the GLAST mission for a 40 Mbps data stream. This stream consists of several different kinds of data that are each placed on a separate virtual channel. One of the GFEP's primary functions is to receive, separate and store these data stream by virtual channel. Some of the downlinked virtual channels must be transmitted to the GLAST Mission Operations Center (MOC) in real time. This real time transmission is the other major function of the GFEP. Secondary functions of the GFEP include the ability to provide information on the data quality of the downlinked stream, support post pass transmission and/or retransmission of the non-real time virtual channels to the MOC.

There are two types of GFEP communications interfaces with the MOC ground system facilities at GSFC. The real time data is transmitted over restricted access networks. The stored data is transmitted over open networks.

The GFEP interfaces with TDRSS WSC terminals are via emitter coupled logic (ECL) clock and data interfaces.

There are no forward link (command) functions provided by the GFEP.

The data downlinked from GLAST via Ku-band has been Reed-Solomon encoded, randomized, and _ rate convolutionally (Viterbi) encoded. WSC equipment will provide the convolutional decoding of the data stream. The GFEP will perform the de-randomization and R-S decoding of the data streams.

3.2 Functional Architecture Description

Since the data is transferred over two different networks, one restricted and one open, two GFEP elements are required to process the downlink stream. The first element is used to process the real time stream and is known as the real-time element (RTE). The second element used to process the data that was not transmitted in real time (i.e., the data stored at WSC), and is known as the playback element (PBE). The remainder of this section will describe the flow through the GFEP to MOC. Since there are two networks involved in transmission to the MOC, the following discussion will first deal with the common paths of the two streams and then describe the branching each of the networks' flows separately.

3.2.1 WSC to GFEP Data Flow

The GFEP system is designed to prevent single points of failure from causing loss of data. To accomplish this, two of each element, RTE and PBE are located at the WSC (one at WSGT and one at STGT). These elements are routed through appropriate switches and patch panels to allow data received at WSGT to be transferred to the STGT network connections and vice versa through the inter-facility link (IFL). The GFEP functional architecture as it relates to existing ground system components is shown in Figure 3-2-1.

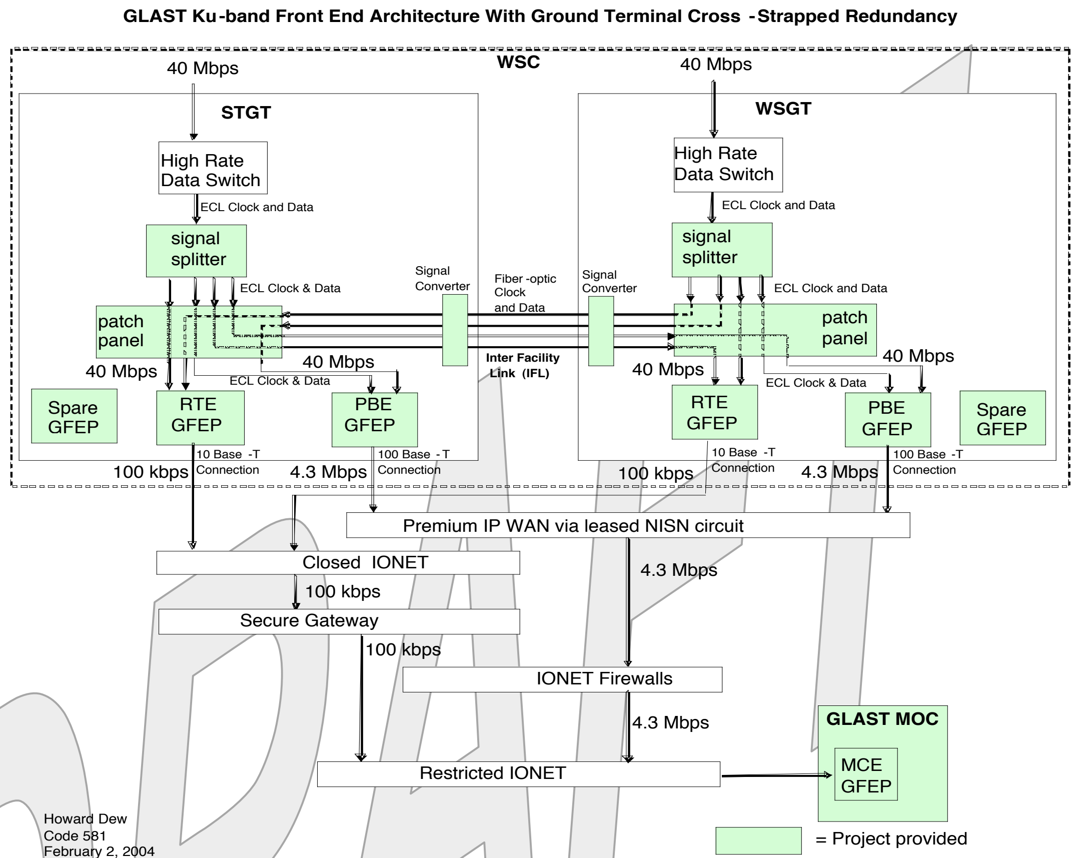

Figure 3.2.1-1 - GFEP System Functional Architecture

Nominally, a pass scheduled at WSGT will use WSGT located GFEP equipment and a pass schedule at STGT will use STGT located GFEP equipment. The data flow begins with reception of a 40 Mbps stream of bit-synched, convolutionally decoded NRZ-L data by a TDRS spacecraft, which is then downlinked and fed to a High Rate Data Switch at WSC (either WSGT or SGT). This stream consists of clock and data.

This stream is then sent to a 1 to 4 data splitter and transmitted simultaneously to 4 patch panel ports (two at WSGT and two at STGT). The output of each of these patch panel ports is transmitted to each GFEP element at each WSC location. At this point, regardless of which WSC location is getting the data, all four GFEP elements are receiving the 40 Mbps data stream. All data sent to given piece of GFEP equipment is stored on that device.

3.2.2 GFEP-RTE to MOC Data Flow

To prevent duplicating the data transmission back to the MOC (doubling the required bandwidth), one of the GFEP elements must be prevented from transmitting its data to the MOC.

For security reasons, RTE will establish a link to the MOC. After the link is established to both RTEs, the MOC transmits control signals to the RTE that will transmit the real time. It also will transmit control signals to the other RTE to prevent it from transmitting the data. The MOC will monitor the status of both links for contingency purposes.

Each RTE receives the full 40 Mbps data stream during a real time contact. When data arrives at the RTE, it immediately stores all the data it receive in the 7 day archive. The RTE simultaneously sends the data to be de-randomized, frame synchronized, and then Reed-Solomon decoded to recover the VCDU. From the VCDU header, the RTE determines whether the data is part of a real time or stored data stream. The real time VCs are transmitted to a network switch that is connected to the Closed IONet. The data is passed through a secure gateway to the Restricted IONet (RIONet). The data is then transmitted over a 256 kbps line via the RIONet to the MOC. At the conclusion of the real time contact the MOC will transmit a control signal to the RTE to terminate the data flow.

3.2.3 GFEP-PBE to MOC Data Flow

To prevent duplicating the data transmission back to the MOC (doubling the required bandwidth), one of the GFEP elements must be prevented from transmitting its data to the MOC.

Unlike the RTE, the MOC completely controls the establishment of the links and configuration of the PBE. The MOC will assure that only one PBE sends data at a time, and monitor the status of both links for contingency purposes.

Each PBE receives the full 40 Mbps data stream during a real time contact. It first de-randomizes the data and then performs Reed-Solomon decoding to recover a VCDU. From the VCDU header, the PBE determines whether the data is part of the real time or stored data stream. Upon conclusion of the real time contact, the MOC will establish a link to the specific PBE and send control signals requesting the PBE begin transmission of the stored VC data via 4.3 Mbps connection to the PIP WAN. The data is passed through appropriate firewalls to reach the Restricted IONet and to the MOC.. At the conclusion of the playback the MOC will terminate the link with the PBE.

3.2.4 GFEP Processing Functions

The GFEP processes GLAST mission data received from the TDRSS ground terminals and distributes it to the MOC Ground System T&C subsystem. GFEP provides interfaces between the MOC and WSC to exchange GFEP configuration data. Return link processing performed by the GFEP consists of real time data delivery, SSR playback processing, and storage of all data received. GFEP capabilities are provided by the following functions:

a. Return Link Processing. Provides the return link processing of return link data in support of CCSDS Advanced Orbiting Systems (AOS) Virtual Channel Data Units (VCDU

b. Data storage and re-transmission. Provides for storage of all return link data received by GFEP equipment for up to 7 (TBD) days. Data in storage can be retransmitted to the MOC at anytime during the seven-day period, subject to ongoing operations constraints.

3.2.5 GFEP Operations Concept

3.2.5.1 MOC Element Operations

Normal operations will connect one prime and one hot backup GFEP element to the MOC. The configuration to support data paths and configuration modes can be controlled at a MOC console. The MOC console T&C component will be able to send configuration data (messages) to designate a pairing of WSC GFEP elements to the MOC thereby connecting specific WSC return link data ports to specific MOC data ports. Configuration data to manage the WSC GFEP element will be processed by the selected MOC element and transferred to the selected WSC elements. Only one of these two WSC GFEP elements will transfer data externally at any one time, starting with the designated prime WSC GFEP element. Internet connectivity loss between the prime WSC GFEP element and the prime MOC element can switch the data path to the backup WSC element, the change can be done manually by the MOC element operator or locally at WSC.

3.2.5.2 WSC GFEP Element Operations

The prime and backup WSC GFEP Elements units will be located in physically separate location at WSC (one at WSGT and one at STGT).

The return link data stream is received by the front end of the element's physical link processor. The physical link processor will separate the virtual channels and determine which to store and which to forward in real time. Uncorrectable VCDUs and fill CADUs will not be processed any further (except for counting them).

The configuration of the element (RTE or PBE) is the same at each WSC ground terminals except: the hot backup WSC element (whether at WSGT or STGT), will be connected via a separate data link to the MOC element. All WSC elements will be connected to all MOC elements via IP connections. During a specific spacecraft contact session (or test data flow), the prime and backup MOC and WSC GFEP elements will be configured to support the data service, but only one will be configured to transmit the data. The prime and backup WSC elements for the service will be connected to both MOC elements to provide additional robustness in selecting backup support, i.e., the prime or backup MOC element can support data services from either WSC elements.

The WSC element configuration to support data devices can be controlled at a MOC console. The MOC will be able to select between a prime or backup MOC element and a prime and backup WSC GFEP element independently .

GFEP return link status monitoring is provided at the WSC element and remotely at the MOC element. Local monitoring is provided for fault isolation and confidence testing. An operator at the WSC element will not be required for normal operations . System administration tasks may be required in some contingency situations (system replacement, reboot, etc.). System upgrades will be performed remotely.

3.2.5.3 Operations Scenarios

These operations scenarios describe GFEP operations as they relate to the interfacing elements of the GLAST MOC ground systems and TDRSS .

3.2.5.3.1 Pre-pass Operations

The process of obtaining data from the GFEP begins with the scheduling of TDRS resources. Since the GFEP does not perform any commanding, the real time operations must be scheduled in conjunction with a TDRS provided forward link service. Once the services are scheduled, a stored command load will be generated and uplinked. Prior to the designated acquisition-of-signal (AOS) the spacecraft stored commands will turn on the Ku- band transmitter. Also prior to AOS the MOC will send control signals to the GFEP equipment, selecting which specific equipment will flow the real time data.

3.2.5.3.2 Real Time Operations

At AOS, the real time data will be detected by the RTE and sent to the MOC. Some time after AOS, the spacecraft commands will begin transmitting the playback stream. The PBE will begin recording the playback data to files, separating them by virtual channel. Some time before loss-of-signal (LOS) the spacecraft commands will stop transmission of the playback stream. A short time later the real time stream will be terminated due to end of TDRS support.

3.2.5.3.3Post Pass Operations

After LOS, the spacecraft stored commands will turn off the Ku-band transmitter. Also after LOS, the ground system will establish the link to the PBEs and begin transmission of the stored virtual channel files to the MOC. At completion of the transfer, the MOC will terminate the connections to the PBEs and deselect both RTEs for data transmission.

Section 4 — Requirements

4.1 System

4.1.1 GFEP System Level Functional Requirements

These requirements apply to the GFEP system as a whole.

Req ID	Requirement	Comments	Source	Source ID
System Level Functional Requirements				
SYSF0010	Provide the operational capabilities for the reception, processing, storage, and delivery of data in formats conforming to GFEP supported standards.	Standard are listed in section 2	GSRD	SYS0010
SYSF0020	Prevent the loss of functional capability due to the receipt of data in formats not conforming to GFEP supported standards.	The system cannot crash from bad data	Derived	
SYSF0030	Use the Universal Time, Coordinated (UTC) reference for all time of day related data, as specified in Reference Document 39.	UTC is the official time of the GLAST mission.	GSRD	SYS0040
SYSF0040	Have no single point of failure that impacts the ability of the system to receive, process, store, retrieve, and transfer real-time Mission Data.	Should this move to RMA?	GSRD	SYS9000
SYSF0050	Provide the capability to support operations 24 hours per day, 7 days per week on a continuous basis for the life of the mission.	This includes all autonomous operation	GSRD	SYS1000

Req ID	Requirement	Comments	Source	Source ID
System Level Functional Requirements				
SYSF0060	Provide the capability to receive return link data from sources external to the GFEP.	For testing and troubleshooting. Assumes the external sources are compliant with the appropriate ICDs.	GSRD	MOC3000
SYSF0065	Provide the capability receive return link data from sources external to the GFEP		Derived	
SYSF0070	Provide the capability for recording of all return link data received from external sources.		GSRD	MOC3000
SYSF0100	Comply with Information Technology (IT) security requirements specified in NPG 2810.1.		GSRD	SYS0500
SYSF0110	Observe the current NASA policy directive, NPD 8010.2C, Use of the Metric System of Measurement in NASA programs.		GSRD	SYS0010
SYSF0120	Comply with the Closed IONET checklist		Derived	
SYSF0170	Support the transmission of the recorded playback data to the MOC post-pass.	Need to be sure MOC and GSRD have requirements for POSTPASS playbacks	gsrdnew	
SYSF0180	Support a retransmission request for any virtual channel file.	Support means accept a request. Retransmission requests can be queued until the current transmission session is complete. Retransmitted data is not allowed to delay or otherwise impact current data capture activities.	GSRD	SN2030
SYSF0190	Accept as input Bit Synchronized, _ rate convolutionally decoded data stream		Derived	

Req ID	Requirement	Comments	Source	Source ID
System Level Functional Requirements				
SYSF0200	Provide the capability to process data received on backup data paths upon determination of failure of the primary data path.	Fundamental redundancy	GSRD	SYS9000
SYSF0210	Provide the capability to perform all processing in support of the CCSDS AOS VCDU Grade-2 Service for all return link data on any physical channel, as specified in Applicable Documents	Did we back down from Grade –2 service somewhere?	GSRD	SYS0020
SYSF0220	Allow for data transport with an unattended MOC		GSRD	
SYSF0230	Perform Frame Synchronization on the data stream		Derived	
SYSF0240	Provide the ability to invert the bits of each VCDU detected to have inverted polarity.		Derived	
SYSF0250	Provide the capability to correct bit slips.	Other data anomalies?	Derived	
SYSF0260	Provide the capability to discard or retain any VCDU that has failed Reed-Solomon (R-S) decoding		Derived	
SYSF0270	Provide the capability to generate, store, and display the count of detected VCDUs received since initial acquisition	Gsrd needs to require tlm status data	gsrdnew	
SYSF0300	Detect and remove Asynchronous Synchronization Markers (ASM) from data stream		Derived	

Req ID	Requirement	Comments	Source	Source ID
System Level Functional Requirements				
SYSF0330	Provide the capability to generate, store, and display the Count of uncorrectable VCDUs since initial acquisition		GSRD	SN4070
SYSF030	Provide the capability to generate, store, and display the Count of symbols corrected for VCDUs since initial acquisition		GSRD	SN4070
SYSF0360	Provide the capability to generate, store, and display the Return Link Clock Rate		GSRD	SN4070
		Do we want to collect all real time requirements in a headered section?		
SYSF0420	Provide the capability to identify forward-ordered playback VCDU data based on the replay flag in the VCDU primary header.	Q for SAI: Does our SSR provide this flag?	GSRD	SN4070?
SYSF0430	Provide the capability to simulate the external interface for return link data.	This is internal to the GFEP element and is for diagnostic and test purposes.	GSRD	SYS3000
SYSF0440	Provide the capability to configure the GFEP return link processing based on control data received from the MOC.	Needed for automated system operation	GSRD	SYS1000

4.1.2 GFEP System Level Performance Requirements

Req ID	Requirement	Comments	Source	Source ID
System Level Performance Requirements				

Req ID	Requirement	Comments	Source	Source ID
System Level Performance Requirements				
SPER0010	Introduce no more than a daily average of one undetected error in 10^{12} bits of Mission Data processed.	10^{12} is to be expected based on historical comparisons to other systems. This is within SPS (10^{-11}) and MSS (2%) tolerances. Testability by exception/analysis.	Derived	
SPER0020	Provide the capability to receive an aggregate input data rate of up to 40 Mbps of spacecraft real time and recorded data		GSRD	SN4110
SPER0030	Provide the capability to concurrently perform all processing in support of CCSDS AOS VCDU Services for all virtual channels		GSRD	MOC0060
SPER0060	Provide the capability to store on-line all received data for a minimum of 7 days.	Includes VC separated. Remove 50 hour requirement from GSRD in SN section	GSRD change	
SPER0070	Provide the capability to transfer stored data files at a rate of at least 4.3 Mbps	LAT data Generation dependent. Lines currently sized at 4.3	Derived	
SPER0080	Support the delivery of 51 kbps real time engineering housekeeping data from the spacecraft	Support the delivery means transfer without buffering or delaying the data	GSRD	MOC4020
SPER0090	Support the delivery of 1 kbps real time burst alert or 1kbps real time housekeeping data from the spacecraft	Support the delivery means transfer without buffering or delaying the data	GSRD	MOC4060

Req ID	Requirement	Comments	Source	Source ID
System Level Performance Requirements				
SPER0100	Support the delivery of up to 49 kbps real time engineering diagnostic data from the spacecraft	Diagnostic data will expand to fill all unused bandwidth up to 100 kbps. If a burst stream is present the rate will be 48 kbps. GSRD need req for diag data	GSRD gsrdchange	MOC4000
SPER0110	Support the delivery of up to 40 Mbps recorded science playback data from the spacecraft	40Mbps is a nominal rate of 39.9 Mbps for science and 100 kbps for real time data. Science Playbacks will only occur in the present of real time data.	GSRD	SN4110
SPER0120	Support the processing following streams simultaneously 1.Real time Housekeeping Telemetry to the MOC 2.Real Time Burst Alert Telemetry to the MOC 3.Real Time Diagnostic Telemetry to the MOC 4. Stored Recorder Playback files from a prior pass or retransmission request to the MOC 5. Real Time GFEP status data to the MOC 6. Real time GFEP control signals from the MOC	Recorder Playback Data acquired in a given real time support will not be transmitted until the real time is concluded.	Derived	

Req ID	Requirement	Comments	Source	Source ID
System Level Performance Requirements				
SPER0130	Support the concurrent storage of the following data streams: 1.Real time Housekeeping Telemetry 2.Real Time Burst Alert Telemetry 3.Real Time Diagnostic Telemetry 4. Recorder Playback Telemetry 5. Real Time GFEP status data 6. Real time GFEP control signals sent from the MOC		Derived	
SPER0140	Support the transmission of 51 kbps real time engineering housekeeping data to the MOC in real time		GSRD	MOC4020
SPER0150	Support the transmission of 1kpbs real time burst alert data to the MOC in real time	GFEP allocation is part of Ground Allocation in GSRD<= 2.5 secs	GSRD	MOC4060
SPER0160	Support the transmission of up to 49 kbps real time engineering diagnostic data to the MOC in real time	Diagnostic data will expand to fill all unused bandwidth up to 100 kbps. If a burst stream is present the rate will be 48 kbps	gsrdnew	
SPER0170	Provide the capability to be maintainable for the life of the system.		Derived	

4.1.3 GFEP System Level RMA Requirements

Req ID	Requirement	Comments	Source	Source ID
System Level RMA Requirements				
SRMA0010	Have a Mean Time Between Failures (MTBF) of 10,000 hours or greater for any LRU, including disk drives, exclusive of all other electromechanical LRUs	Line Replacement Unit (LRU)	GSRD	
SRMA0020	Have an operational availability of 0.9998 or greater for all functionality required to support the receipt, processing and delivery of return link channels for real-time mission data handling.	Assumes all other components are failure free.	GSRD	SYS1050
SRMA0030	Have an operational availability of 0.9998 or greater for all functionality required to support real time data capture.	Assumes all other components are failure free	GSRD	SYS1050
SRMA0040	Have an operational availability of 0.998 or greater to support non-real-time mission data handling	GSRD needs requirement for science availability	gsrdnew	
SRMA0050	Have an operational availability of 0.96 or greater for all other functionality	GSRD needs requirement for other category	gsrdnew	

4.2 Element

4.2.1 GFEP - Network Interface Functional Requirements

Req ID	Requirement	Comments	Source	Source ID
GFEP - Network Interface Functional Requirements				
NIFF0010	Provide the capability to support the protocols as specified in Reference Documents.	Check Docs	Derived	
NIFF0020	Comply with a standard IP addressing convention.		Derived	
NIFF0040	Utilize the IP interface for real-time mission data delivery		Derived	
NIFF0050	Utilize the IP interface for science mission data delivery		Derived	

4.2.2 MOC - GFEP Control Requirements

Req ID	Requirement	Comments	Source	Source ID
GFEP - MOC Functional Requirements				
MOCF0040	Interface with the MOC to receive link configuration data	Status msgs for data processing and GFEP stats. Status messages for link configuration" "Status messages for data processing" " Status messages for GFEP"	GSRD	MOC4050
MOC0050	Interface with the MOC to send link configuration data		GSRD	MOC4050

4.2.3 GFEP - WSC Interface Functional Requirements

Req ID	Requirement	Comments	Source	Source ID
GFEP - WSC Interface Functional Requirements				
WIFF0050	Provide the capability to receive a UTC time code signal from WSC.	From standard signal generator such as NAS-36.	GSRD	SYS0040
WIFF0060	Provide the capability to exchange status data with WSC in a serial clock/data format	Only GFEP status data required by WSC as defined in the ICD	derived	
WIFF0070	Provide the capability to switch any return link data stream to any of the return link ports based on manual coordination with MOC operations.	GFEP equip at WSC can be operated manually by WSC personnel for troubleshooting and diagnostic purposes as needed. Not required for normal operations.	derived	

Req ID	Requirement	Comments	Source	Source ID
GFEP - WSC Interface Functional Requirements				
WIFF0080	Be capable of attaching to existing networks	This is to adapt to system upgrades.	Derived	

4.2.4 GFEP - WSC Interface Performance Requirements

Req ID	Requirement	Comments	Source	Source ID
GFEP – WSC Interface Performance Requirements				
WPER0020	Provide four ports at each TGT to exchange return link physical channel data.	One real time prime port, One real time backup port, One playback prime port, and One playback backup port	Derived	
WPER0030	Support a rate of up to 40 Mbps on any return link interface	Every	GSRD	SN4110

A APPENDIX A - Acronyms

APID	Application Identification
AR	Autonomous Re-point
ATS	Absolute Time Sequence
BAP	Burst Alert Processor
CCL	Closed-Circuit Loop
CCSDS	Consultative Committee for Space Data Systems
CLCW	Command Link Control Word
COP-1	Communications Operation Procedure-1
CRC	Cyclic Redundant Checking
CVT	Current Value Table
DAS	Demand Access System
DOWD	Differenced One-way Doppler
DTAS	Data Trending and Analysis System
EU	Engineering Unit
FARM	Frame Acceptance and Reporting Mechanism
FDF	Flight Dynamics Facility
FOT	Flight Operations Team
FSW	Flight Software
FTP	File Transfer Protocol
GBM	GLAST Burst Monitor
GCMR	Ground Communication Message Request
GCN	Gamma-ray Burst Coordinates Network
GFEP	GLAST Front End Processor
GIOC	GBM Instrument Operations Center
GLAST	Gamma ray Large Area Space Telescope
GN	Ground Network
GPS	Global Positioning System
GRB	Gamma Ray Burst
GSFC	Goddard Space Flight Center
GSRD	Ground System Requirements Document
GSSC	GLAST Science Support Center
HEASARC	High Energy Astrophysics Science Archive Research Center
HK	Housekeeping
I&T	Integration and Test
ICD	Interface Control Document
IIRV	Improved Interrange Vectors
IOC	Instrument Operations Center
IONet	IP Operational Network
IOT	Integrated Observatory Timeline

IP	Internet Protocol
IT	Information Technology
ITOS	Integrated Test and Operations System
Kbps	kilobits per second
KSC	Kennedy Space Center
L&EO	Launch and Early Orbit
LAT	Large Area Telescope
LIOC	LAT Instrument Operation Center
MA	Multiple Access
MOC	Mission Operations Center
MOMS	Mission Operations and Mission Services (contract)
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NCC	Network Control Center
NISN	NASA Integrated Services Network
NORAD	North American Aerospace Defense Command
NPD	NASA Policy Directive
OIG	Orbital Information Group
PDB	Project Database
PPT	Pre-planned Timeline
PSLA	Project Service Level Agreement
RF	Radio Frequency
RT	Real-time
RTS	Relative Time Sequence
S/C	Spacecraft
SA	Single Access
SAA	South Atlantic Anomaly
SCAMA	Switch Conferencing And Monitoring Arrangement
SERS	Spacecraft Emergency Response System
SLAC	Stanford Linear Accelerator Center
SN	Space Network
SSA	S-band Single Access
SSR	Solid State Recorder
STGT	Second TDRSS Ground Terminal
STOL	Systems Test and Operations Language
STPS	Software Telemetry Processing System
SWG	Science Working Group
SWSI	Space Network Web-based Scheduling Interface
T&C	Telemetry and Command
TBD	To Be Determined
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TDRSS	Tracking and Data Relay Satellite System
TLE	Two Line Elements
ToO	Target of Opportunity
TUT	TDRSS Unscheduled Time

UDP/IP	Universal Data Protocol
UPS	Uninterruptible Power Supply
USN	Universal Space Network
UTC	Universal Time Coordinated
UTCF	UTC Correction Factor
VC	Virtual Channel
VCID	Virtual Channel Identifier
VDS	Voice Distribution System
WDISC	WSC Data Interface Service Capability
WSC	White Sands Complex
WSGT	White Sands Ground Terminal
WWW	World Wide Web